**SCH4U Unit 5 Electrochemistry:**

Lesson 3: Balancing Redox Reactions using the Oxidation Number Method.

Review Video can be found at <http://www.youtube.com/watch?v=ICMfgSBNQzs>

Redox Reaction: A reaction that takes place where oxidation and reduction reactions occur simultaneously.

**Oxidation:** Loss of electrons

**Reduction:** Gain of electrons

LEO the lion says GER

LEO : **L**oss of **E**lectrons = **O**xidation, GER: **G**ain of **E**lectrons = **R**eduction

Table 1: Common Oxidation Numbers

|  |  |  |
| --- | --- | --- |
| Atom or ion | Oxidation number | Examples |
| All atoms in elements | 0 | Na is 0, Cl in Cl2 is 0 |
| Hydrogen in all compounds | +1 | H in HCl is +1 |
| Hydrogen in hydrides | -1 | H in LiH is -1 |
| Oxygen in all compounds | -2 | O in H2O is -2 |
| Oxygen in peroxides | -1 | O in H2O2 is -1 |
| All monatomic ions | Charge on ion | Na+ is +1, S2- is -2 |

Refining process of Aluminum:

2Al2O3 (l) + 3C (S) → 4 Al(l) + 3CO2(g)

Al3+ + 3e- → Al (reduction)

Combustion of Methane:

Oxidation

-4 +1 0 +1 -2 +4 -2

CH4 + O2 → 2H2O + CO2

Reduction

Table 1: Oxidation numbers

|  |  |  |
| --- | --- | --- |
| Elements | In the reactants | In the Products |
| H | +1 | +1 |
| O | 0 | -2 |
| C | -4 | +4 |

Summary

Procedure for Balancing Redox Equations Using Oxidation Numbers

**Step 1** Assign oxidation numbers and identify the atoms/ions whose oxidation number change.

**Step 2** Using the change in oxidation numbers, write the number of electrons transferred per

atom.

**Step 3** Using the chemical formulas, determine the number of electrons transferred per reactant.

(Use formula subscripts to do this.)

**Step 4** Calculate the simplest whole number of coefficients for the reactants that will balance the

total number of electrons transferred. Balance the reactants and products.

**Step 5** Balance the O atoms using H2O(l), and then balance the H atoms using H+(aq).

*For basic solutions only*

**Step 6** Add OH- (aq) to both sides equal in number to the number of H+(aq) present.

**Step 7** Combine H+(aq) and OH-(aq) on the same side to formH2O(l) and cancel the same number

of H2O(l) on both sides.

***Chalkboard Examples***

***Example 1:*** Hydrogen sulfide gas smells terrible, like rotten eggs. The reaction of burning hydrogen sulfide gas is as follows:

H2S(g) + O2(g) → SO2(g) + H2O(g)

Oxidation

+1 -2 0 +4 -2 +1 -2

H2S(g) + O2(g) → SO2(g) + H2O(g)

Reduction

Sulfur is oxidized from -2 to +4 → difference of 6 = 6e-

Oxygen is reduced from 0 to -2 → difference of 2 = 2e-

+1 -2 0 +4 -2 +1 -2

H2S(g) + O2(g)  → SO2(g)  + H2O(g)

6e-/S atom 2e-/O atom

6e-/H2S 4e-/O2

+1 -2 0 +4 -2 +1 -2

H2S(g) + O2(g)  → SO2(g)  + H2O(g)

6e-/S atom 2e-/O atom

6e-/H2S 4e-/O2

x 2 = x 3

12 12

A common whole number was found in order to balance the redox electron transfer process.

2 H2S(g) + 3 O2(g)  → SO2(g)  + H2O(g)

The multiplier then becomes the stoichiometric coefficient (2 for H2S, 3 for O2)

Using the new coefficients, balance the rest of the equation.

2 H2S(g) + 3 O2(g)  → 2 SO2(g)  + 2 H2O(g)

***Example 2:*** Chlorate ions and iodine react in an acidic solution to produce chloride ions and

iodate ions.

ClO3-(aq) + I2(aq) → Cl-(aq) + IO3-(aq)

Step 1: assign oxidation numbers and determine changes.

+5 -2 0 -1 +5 -2

ClO3-(aq) + I2(aq)  → Cl-(aq)  + IO3-(aq)

Cl from +5 to -1→ 6 = 6e-

I from 0 to +5 → 5 = 5e-

Step 2/3: Using the # of e-, write the # of e- transferred/atom. Determine per reactant.

+5 -2 0 -1 +5 -2

ClO3-(aq) + I2(aq)  → Cl-(aq)  + IO3-(aq)

6e-/Cl 5e-/I

6e-/ClO3-  10e-/I2

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Step 4: Calculate simplest whole number to balance the electrons. Balance the reactants/products

+5 -2 0 -1 +5 -2

5 ClO3-(aq) + 3 I2(aq)  → 5 Cl-(aq)  + 6 IO3-(aq)

6e-/Cl 5e-/I

6e-/ClO3-  10e-/I2

x 5 x 3

Step 5: Balance O using using H2O(l) and balance H using H+(aq)

3H2O(l) + 5ClO3-(aq) + 3I2(aq)  → 5Cl-(aq)  + 6IO3-(aq)

3H2O(l) + 5ClO3-(aq) + 3I2(aq)  → 5Cl-(aq)  + 6IO3-(aq) + 6 H+(aq)

***Example 3:*** Permanganate ions and sulfite ions react in basic solution to form sulfate and   
 manganese oxide ions.

MnO4-(aq) + SO32-(aq) → SO42-(aq) + MnO2(s)

+7 -2 +4 -2 +6 -2 +4 -2

MnO4-(aq) + SO32-(aq) → SO42-(aq) + MnO2(s)

Mn +7 → +4; 3 = 3e-

S +4 → +6; 2 = 2e-

+7 -2 +4 -2 +6 -2 +4 -2

MnO4-(aq) + SO32-(aq) → SO42-(aq)  + MnO2(s)

3e-/Mn 2e-/S

3e-/MnO4- 2e-/SO32-

x 2 x 3

+7 -2 +4 -2 +6 -2 +4 -2

2 MnO4-(aq) + 3 SO32-(aq) → 3 SO42-(aq) + 2 MnO2(s) Equation is now balanced.

Balance O with H2O and balance H with H+

2 H+ + 2 MnO4-(aq) + 3 SO32-(aq) → 3 SO42-(aq) + 2 MnO2(s) + H2O(l)

Balance H+ with OH-

2 H+ + 2 OH- + 2 MnO4-(aq) + 3 SO32-(aq) → 3 SO42-(aq) + 2 MnO2(s) + H2O(l) + 2OH-

2H2O + 2 MnO4-(aq) + 3 SO32-(aq) → 3 SO42-(aq) + 2 MnO2(s) + H2O(l) + 2OH-

Cancel the water molecules

H2O + 2 MnO4-(aq) + 3 SO32-(aq) → 3 SO42-(aq) + 2 MnO2(s) + 2OH-